

## **B. Tech. in AGRICULTURE ENGINEERING**

### **Syllabus of Paper – 1**

#### **THEORY OF MACHINES**

Terminology : Definitions - Kinematic links - Pairs - Chain - Machines and mechanism - Types and uses – Kinematic inversion of four bar chain and slider crank mechanism. Velocity and acceleration in simple mechanisms - Vector polygon and instantaneous centre methods – Coriolis component of acceleration. Friction and applications : Sliding and rolling friction –friction in screw threads-Bearing and lubrication- Friction clutches- Belt drives- Friction aspects in brakes. Motion of cam and follower : Cam and follower - types - application – displacement diagrams - profile layout for uniform velocity - Uniform acceleration and retardation - simple harmonic and cycloidal motion. Gears and gear trains : Gears - classification - terminology -law of gearing - tooth profile - interference between rack and pinion. Gear trains - simple - compound reverted. Simple epicyclic gear trains. Flywheel and balancing : Inertia - turning moment - flywheel - fluctuation of speed and energy. Balancing of rotating masses and reciprocating masses.

#### **DESIGN OF BASIC MACHINE ELEMENTS**

Stresses in machine members : Introduction to design process- factor influencing the machine design, selection of material based on mechanical properties- Direct, bending and torsional stress equations- calculation of Principal stresses for combined loading. Design of curved beams- factor of safety – theories of failure-stress concentration- design of variable loading- Soderberg and Goodman relations. Design of power transmission systems : Selection of V-Belts and pulleys- selection of flat belts and pulleys- wire ropes and pulleys-selection of transmission chains and sprockets. Design of pulleys and sprockets. Design of shafts and couplings : Design of solid and hollow shafts based on strength and rigidity- Design of keys, keyways and splines- Design of rigid and flexible couplings. Design of bolts and nuts - knuckle and cotter joints. Design of energy storing elements : Design of helical, leaf, disc and torsional springs under constant loads and varying loads – Concentric torsion springs. Design of gears and bearings : Gears - spur gear and helical gear - terminology - strength of gear teeth - Lewis equation - Buckingham equation. - Failure of gear teeth.- Applications of different types of Gears - Types of bearings – sliding contact and rolling contact types. – Bearing selection based on application - Lubrication in journal bearings – calculation of bearing dimensions.

#### **FARM TRACTORS**

Tractors : Classification of tractors - Tractor engines – construction of engine blocks, cylinder head and crankcase - features of cylinder, piston, connecting rod and crankshaft – firing order combustion chambers. Engine systems : Valves-inlet and outlet valves – valve timing diagram. Air cleaner- exhaust – silencer. Cooling systems - lubricating systems - fuel system – governor-electrical system. Transmission systems :Transmission - clutch - gear box - sliding mesh - constant mesh - synchro mesh. Differential, final drive and wheels. Steering geometry - steering systems - front axle and wheel alignment. Brake - types - system. Hydraulic systems : Hydraulic system - working principles, three point linkage - draft control - weight transfer, theory of traction - tractive efficiency – tractor chassis mechanics - stability - longitudinal and lateral. Controls - visibility - operators seat. Power tiller, bulldozer and tractor testing : Power tiller - special features - clutch - gear box - steering and brake. Makes of tractors, power tillers and bulldozers. Bulldozer- salient features – turning mechanism, track mechanism, components – operations

performed by bulldozers. Types of tests- test procedure - need for testing & evaluation of farm tractor -Test code for performance testing of tractors and power tillers.

## **FARM MACHINERY AND EQUIPMENT**

Farm mechanization : Objectives - Tillage - methods – primary tillage implements - secondary tillage implements - animal drawn ploughs - construction. Types of farm implements – trailed, mounted . Field capacity - forces acting on tillage tool. Primary and secondary tillage implements : Mould board plough- attachments – mould board shapes and types. Disc plough – force representation on disc – Types of disc ploughs – Subsoiler plough - Rotary plough. Cultivators - types - construction. Disc harrows - Bund former - ridger – leveller. Basin lister-Wetland preparation implements. Sowing and fertilizing equipment : Crop planting - methods - row crop planting systems - Devices for metering seeds – furrow openers – furrow closers- types – Types of seed drills and planters – calibration-fertilizer metering devices - seed cum fertilizer drills – paddy transplanters – nursery tray machines. Weeding and plant protection equipment : Weeding equipment – hand hoe – long handled weeding tools – dryland star weeder – wetland conoweeder and rotary weeder – Engine operated and tractor weeders. Sprayers –types-classification – methods of atomization, spray application rate, droplet size determination – volume median diameter, numerical median diameter – drift control. Harvesting machinery and Special farm equipment : Principles of cutting crop, types of harvesting machinery, vertical conveyor reaper and binder combine harvesters, balers, threshers, tractor on top combine harvester, combine losses. Mowers and weeding equipment, Sprayers and Dusters, Threshers and Harvesters, potato diggers, tree cutting machines – post hole diggers, specialized farm equipment.

## **UNIT OPERATIONS IN AGRICULTURAL PROCESSING AND POST HARVEST TECHNOLOGY**

Evaporation and size reduction : Unit operations in agricultural processing – Evaporation - Types of evaporators – Capacity – Energy balance – Drying - principles - constant and falling rate of drying - thin layer and deep bed drying - types of dryers – Size reduction - Rittinger, Bond, Kick's laws of crushing – crushers – types – crushing rolls – hammer mills – fine crushers. Mechanical separation, crystallization and distillation : Screening – Trommel - Filtration – definition – filtration equipment – filter press – Stoke's law – Sedimentation – centrifuging – Crystallization – crystallizers – Distillation – equipment. Heat and Mass transfer : Basic concepts of conduction, convection and radiation –Fourier law of conduction – Conduction through plane walls, cylinders and spherical systems – Convective heat transfer coefficients – Boundary Layer concept – Types of convection – Flow over plates, Cylinders and spheres – Laminar and turbulent flow – Combined Laminar and turbulent flow - Dimensional analysis – law of radiation – Stefan Boltzmann law, Kirchoff law – Black body radiation – Diffusion mass transfer – Fick's Law of diffusion – Steady state molecular diffusion – Convective mass transfer – Momentum, heat and mass transfer analogy – Convective mass transfer correlations. Engineering properties of agricultural materials : Post harvest engineering of crops – objectives - post harvest losses in agricultural commodities - structure and composition of food grains - optimum stage of harvest - engineering properties of agricultural materials - Moisture content – measurement - grain moisture meter – equilibrium moisture content – psychrometry. Threshing and grading : Threshing - traditional methods - mechanical threshers - principles and operation –. Cleaning and grading – principles - air screen cleaner – separators (cylinder, spiral, magnetic, inclined belt) - effectiveness of separation and performance index - color sorter - Groundnut decorticator – Maize Sheller. Processing of cereals & pulses, material handling and storage : Paddy processing -

parboiling - methods - dehusking of paddy – methods - rice polishers - types - degree of polishing - layout of modern rice mill - manufacture of beaten, expanded and puffed rice – Wheat milling processes and equipment - processing of pulses and corn - Material handling equipment - belt conveyor - screw conveyor and bucket elevators - storage conditions for safe storage - traditional methods – factors affecting storage – storage losses - modified and controlled atmosphere storage.

## **FOOD AND DAIRY ENGINEERING**

Properties and processing of milk : Dairy Industry – importance and status – Milk Types – Composition and properties of milk - Production of high quality milk - Method of raw milk procurement and preservation - Processing – Straining - Filtering and Clarification - cream separation – Pasteurization – Homogenization - sterilization, UHT processing and aseptic packaging – emulsification - Fortification. Dairy products : Manufacture of Milk Powder - Processing of Milk Products - Condensed Milk - Skim milk - Butter milk - Flavoured Milk, whey, casein, yoghurt and paneer - Manufacture of Butter - Cheese Ghee, ice creams and frozen desserts - standards for milk and milk products - Packaging of Milk and Milk Products - Cleaning and Sanitation - Dairy effluent treatment and disposal. Food and its properties, reaction and kinetics : Constituents of food - thermal processing of foods - cooking, blanching, sterilization, pasteurization, canning - Interaction of heat energy on food components, reaction kinetics, Arrhenius equation, TDT curves - water activity, sorption behaviour of foods – isotherm models - monolayer value, BET isotherms, Raoult's law, Norrish, Ross, Salwin - Slawson equations.

Processing and preservation of foods : Coffee, Tea processing - Concentration of foods, freeze concentration - osmotic and reverse osmotic concentration - drying and dehydration of food - Tray, tunnel, belt, vacuum and freeze dryers - rehydration of dehydrated foods - Fat and oil processing, sources, extraction, methods and equipment, refining of oils, hydrogenation, manufacture of margarine - Food preservation methods - preservation by irradiation, microwave and dielectric heating of food. Packaging and quality control: Food packaging, importance, flexible pouches - retort pouches - aseptic packaging, granules, powder and liquid packaging machines - nanotechnology – principles - applications in food processing – food plant location - Quality control of processed food products - Factors affecting quality.

## **Syllabus of Paper - 2**

### **HYDROLOGY AND WATER RESOURCES ENGINEERING**

Precipitation and abstractions: Hydrological cycle- Meteorological measurements – Requirements, types and forms of precipitation - Rain gauges-Spatial analysis of rainfall data using Thiessen and Isohyetal methods-Interception - Evaporation. Horton's equation, pan evaporation measurements and evaporation suppression - Infiltration-Horton's equation - double ring infiltrometer, infiltration indices. Runoff : Watershed, catchment and basin - Catchment characteristics - factors affecting runoff - Run off estimation using empirical - Strange's table and SCS methods – Stage discharge relationships- flow measurements- Hydrograph – Unit Hydrograph – IUH. Flood and drought : Natural Disasters-Flood Estimation- Frequency analysis- Flood control- Definitions of droughts-Meteorological, hydrological and agricultural droughts- IMD method-NDVI analysis- Drought Prone Area Programme (DPAP). Reservoirs : Classification of reservoirs, General principles of design, site selection, spillways, elevation – area - capacity - storage estimation, sedimentation - life of reservoirs – rule curve.

### **IRRIGATION AND DRAINAGE ENGINEERING**

Water resources and irrigation requirement : Water Resources- River basins-Development and Utilization in India - Irrigation – duty and delta - Rooting characteristics - Moisture use of crop, Evapotranspiration - ET plot - Crop water requirement - Effective rainfall - Scheduling - Irrigation requirement - Irrigation frequency, Irrigation efficiencies. Methods of irrigation : Methods of Irrigation – Surface and Subsurface methods – Drip and Sprinkler - Hydraulics and design - Erodible and non-erodible, Kennedy's and Lacey's theories, Materials for lining water courses and field channel, Water control and diversion structures - Underground pipeline irrigation system. Drip irrigation design : Drip irrigation - Components- Drinker- types and equations governing flow through drippers-Wetting pattern- Chemigation - Pump capacity- Installation- Operation and maintenance of Drip irrigation system - Design of surface and sub-surface drip irrigation. Sprinkler irrigation design : Sprinkler irrigation- Components and accessories - Hydraulic design - Sprinkler selection and spacing- Capacity of sprinkler system - types - Sprinkler performance- Sprinkler discharge- Water distribution pattern- Droplet size, filtering unit, fertigation - System maintenance. Diversion and impounding structures: Head works –Weirs and Barrage –Types of impounding structures - Factors affecting, location of dams -Forces on a dam -Design of Gravity dams- Earth dams, Arch dams – Spillways -Energy dissipaters. Canal irrigation and Command Area development: Classification of canals- Alignment of canals – Design of irrigation canals– Regime theories - Canal Head works – Canal regulators - Canal drops – Cross drainage works – Canal Outlet, Escapes –Lining and maintenance of canals - Excess irrigation and water logging problem - Command area - Concept, Components of CADP - On Farm Development works, Farmer's committee - its role for water distribution and system operation - rotational irrigation system. Agricultural drainage : Agricultural drainage - Drainage coefficient; principles of flow through soils, Darcy's law – infiltration theory, Surface drainage systems - Subsurface drainage - Design of subsurface drainage - Pipe materials - mole drains, drainage wells, Leaching requirements - irrigation and drainage water quality - recycling of drainage water for irrigation.

### **GROUNDWATER AND WELL ENGINEERING**

Hydrogeologic parameters : Water Balance – Distribution of subsurface water – Water bearing properties of Rocks – Types of Aquifers – Aquifer properties Estimation – Pumping test :–

Permeability, Specific yield, transmissivity and Storage coefficient – Methods of Estimation – Ground water table fluctuation method – GEC Norms – Ground water development and potential in India - Groundwater prospectives - Geophysical techniques – Electrical resistivity survey

Well hydraulics : Darcy's law – Groundwater Flow Equation – Steady state flow – Dupuit Forcheimer Assumption – Theim's Equation - unsteady flow – Theis method and Jacob method – Image well theory – Partial penetration of wells. Well design : Design characteristics – Design of wells - Well diameter, depth and Well screen design – Materials for well screens – Well casing – Design of collector wells and Infiltration gallery – Dug wells versus tube wells. Well construction and maintenance : Types of wells – Well drilling - Boring, Jetting – Rotary drilling, Hammer drilling - Construction – Installation of pipes and screens - Well development, Completion and disinfection – Well maintenance – Well performance test – Well effectiveness – Well loss – Pumping equipment – Rehabilitation of wells and borewells. Special topics: Artificial Recharge Techniques – Sea water Intrusion – Introduction to Groundwater modeling Techniques – Ground water pollution and legislation - Groundwater quality – Dose response assessment – Risk analysis.

## **SOIL AND WATER CONSERVATION ENGINEERING**

Soil erosion principles : Approaches to soil conservation – Soil conservation in India - Erosion – Agents - Causes - Mechanics of water erosion – Soil erosion problems - Types of water erosion: Raindrop erosion, Sheet erosion, Rill erosion, Gully erosion, Stream bank erosion – Classification of Gully – Gully Control Structures: Drop Spillway, Drop Inlet, Chute Spillways - Prerequisites for soil and water conservation measures. Estimation of soil erosion :Runoff computation for soil conservation: SCS-CN method – Evolution of USLE : Applications and Limitations – MUSLE – RUSLE - Permissible erosion – Land use capability classification - Classification of eroded soils. Erosion control measures : Agronomic practices: contour cultivation - strip cropping – tillage practices – Soil management practices – Bunding: Types and design specifications - Mechanical measures for hill slopes – Terracing: Classification and design specification of bench terrace – Grassed waterways: Location, construction and maintenance – Types of temporary and permanent gully control structures. Water conservation measures : In-situ soil moisture conservation – Water harvesting principles and techniques: Micro catchments, catchment yield using morphometric analysis - Farm ponds: Components, Design, Construction and Protection – Check dams - Earthen dam – Retaining wall. Sedimentation : Sediment - Sources – Types of sediment load – Mechanics of sediment transport – Estimation of bed load – Sediment Graph - Reservoir sedimentation: Basics - Factors affecting sediment distribution pattern, Rates of reservoir sedimentation - Silt Detention Tanks – sediment control methods.

## **SOLAR AND WIND ENERGY ENGINEERING**

Solar energy radiation and solar thermal collectors : Solar radiation availability - radiation measurement – transmittance - absorptance – Basic earth sun angles - estimation of average solar radiation, radiation on tilted surface - Flat plate collectors - heat transfer correlations - collector efficiency - heat balance – absorber plate – types - selective surfaces. Solar water heaters - types-their performance. Solar driers – types – heat transfer - performance of solar dryers – agro industrial applications. Solar concentrating collectors : Concentrating collectors – types – reflectors - solar thermal power stations – principle and applications - Solar energy storage systems – thermal - sensible and latent heat, chemical, electrical, electro-magnetic energy storage – selection of materials for energy storage - Solar distillation – application - Solar stills - types - Solar pond - performance – characteristics - applications – Solar refrigeration. Solar PV technology : Solar photovoltaic technology –introduction – solar cell basics – Types of solar

cells and modules – encapsulation – Design of solar PV system – load estimation - batteries – invertors – operation - system controls. Standalone and grid connected systems - PV powered water pumping - Hybrid system - Solar technologies in green buildings. Wind energy : Nature of the wind – power in the wind – factors influencing wind – wind energy potential and installation in India- wind speed monitoring - wind resource assessment -wind power laws - velocity and power duration curves - Betz limit - site selection. Wind mill types and applications : Wind energy conversion devices - classification, characteristics, applications – Design of horizontal axis wind mill rotor diameter - Wind energy storage - wind farms - wheeling and banking - testing and certification procedures. Water pumping - Hybrid systems – Wind mill safety and environmental aspects.

## **BIO ENERGY RESOURCE TECHNOLOGY**

Bio resource : Origin – biomass types and characteristics- biomass conversion technology- Biodegradation - steps in biogas production- parameters affecting gas production- Types of biogas plants- Construction details- operation and maintenance. Bio energy : Slurry handling- enrichment and utilization – Biogas appliances- Biochemical characteristics of bio resources- Bioenergetics – Biocatalysis –Kinetics of product formation. Bio reactors and fermentors : Bio reactors/ fermentors – Batch type – continuous stirred tank reactors- Biological waste water treatment- Activated sludge process- Down stream processing-Recovery and purification of products. Alcohol production : Ethanol production - Acid hydrolysis - enzyme hydrolysis-Methanol synthesis - Antibiotics-enzymes- principles of thermochemical conversion – combustion - pyrolysis- Gasification – types of gasifiers. Energy and environment : Principles of operation- chemical reaction- cleaning and cooling - Utilization- Improved wood burning stove - Energy plantations- Biomass briquetting - co generation- Impact on Environment - Bioenergy policy.

## **AGRICULTURAL WASTE MANAGEMENT**

Introduction : Types of agriculture wastes - characteristics – classification of agro wastes - recycling and utilization potential- current constraints in collection and handling of agricultural wastes – its environmental impact. Composting : Definition- Solid waste suitable for composting – Methods of composting - vermicomposting - Mineralization process in composting - Biochemistry of composting – Factors involved – Infrastructure required – maturity parameters – value addition – application methods. Biomass briquetting : Definition – potential agro residues and their characteristics for briquetting – fundamental aspects and technologies involved in briquetting – economic analysis of briquetting – setting up of briquetting plant- appliances for biomass briquettes. Biochar production : Definition - characteristics of agro wastes suitable for Biochar production – Methods of Biochar production – fast and slow pyrolysis – characteristics of Biochar – role of Biochar in soil nutrition and carbon sequestration. Biogas and Bio Ethanol production : Screening of suitable lingo cellulosic substrate for biogas production -determination of bio-energy potential of agro-waste by estimating total solids - volatile solids - Calorific value- per cent total carbohydrates, moisture, lignin and cellulosic contents – preparation of feed stocks for anaerobic bio- digestion – types of digesters – factors affecting - nutrient value and utilization of biogas slurry. Ethanol production from lingo cellulosic wastes - Processing of Biomass to Ethanol –pre-treatment-fermentation-distillation.

\*\*\*\*\*